NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH Public Access

Author Manuscript

Matern Child Health J. Author manuscript; available in PMC 2013 October 01.

Published in final edited form as:

Matern Child Health J. 2012 October ; 16(7): 1491–1499. doi:10.1007/s10995-011-0915-5.

Residential Segregation and the Health of African-American Infants: Does the Effect Vary by Prevalence?

Kwame A. Nyarko, B.A. [PhD Student] and

Dept. of Health Management and Policy College of Public Health University of Iowa 5233 Westlawn Iowa City, IA 52242 Phone: 319-335-7180 Fax: 319-384-5125 kwame-nyarko@uiowa.edu

George L. Wehby, Ph.D.* **[Assistant Professor]**

Dept. of Health Management and Policy College of Public Health University of Iowa 200 Hawkins Drive, E205 GH Iowa City, IA 52242

Abstract

Objectives—Segregation effects may vary between areas (e.g., counties) of low and high low birth weight (LBW; <2500 grams) and preterm birth (PTB; <37 weeks of gestation) rates due to interactions with area differences in risks and resources. We assess whether the effects of residential segregation on county-level LBW and PTB rates for African-American infants vary by the prevalence of these conditions.

Methods—The study sample includes 368 counties of 100,000 or more residents and at least 50 African-American live births in 2000. Residentially segregated counties are identified alternatively by county-level dissimilarity and isolation indices. Quantile regression is used to assess how residential segregation affects the entire distributions of county-level LBW and PTB rates (i.e. by prevalence).

Results—Residential segregation increases LBW and PTB rates significantly in areas of low prevalence, but has no such effects for areas of high prevalence. As a sensitivity analysis, we use metropolitan statistical area level data and obtain similar results.

Conclusion—Our findings suggest that residential segregation has adverse effects mainly in areas of low prevalence of LBW and preterm birth, which are expected overall to have fewer risk factors and more resources for infant health, but not in high prevalence areas, which are expected to have more risk factors and fewer resources. Residential policies aimed at area resource improvements may be more effective.

Keywords

African-Americans; infant health; residential segregation; quantile regression; racial disparities

Introduction

African-American infants experience significantly higher rates of low birth weight (LBW; <2500 grams) and preterm birth (PTB; <37 weeks of gestation**)** compared to White infants (1-4). In 2008, the LBW and PTB rates of African-American infants (13.7% and 17.5%, respectively) were about twice those of White infants (7.2% and 11.1%) (5). LBW and PTB are important predictors of future health (6), and human capital accumulation (7, 8);

*Corresponding author Phone: 319-384-5133 Fax : 319-384-5125 george-wehby@uiowa.edu.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

therefore racial disparities in these early infant health conditions may contribute to disparities in other health and human capital indicators later in life.

Racial disparities in infant health are of complex etiology and may occur due to several individual, social, economic, political and geographic factors. For example, individual-level demographic and behavioral factors, such as maternal age and inadequate prenatal care use have been reported to be associated with racial disparities in LBW (9). Institutional and individual-level racial discrimination also has adverse effects on child and adult health (10-12). Improvements in maternal socioeconomic conditions and family income have been shown to significantly reduce LBW rates (by 48%) among poor White women. However, similar economic improvements were found to have smaller and insignificant effects on LBW rate (decrease by 15%) among African-Americans. It has been suggested that residential segregation may be a major reason why upward socioeconomic mobility is not as effective among African-Americans (13).

Racial residential segregation between two or more racial/ethnic groups is the extent to which these groups are geographically separated in residential location (14). Segregation can be empirically measured in different ways as described below. A large literature points to residential segregation as one of the underlying causes of racial disparities in infant health including in LBW and PTB (13, 15-19). Racial residential segregation may causally affect infant health including LBW and PTB through several pathways. Segregation may increase neighborhood poverty and reduce economic growth (4). The resulting neighborhood economic deprivation reduces the availability of resources and services (17, 20, 21) needed for enhancing maternal and fetal health and reducing LBW and PTB rates. These resources may include healthy food outlets (22), safe and clean environments (23), availability of and access to high quality healthcare facilities and health professionals (24), opportunities for quality education, skilled employment, and housing (25), and improved municipal services (16). Neighborhood poverty due to segregation may increase crime rates and maternal exposure to stress, which worsens both maternal psychosocial health and fetal/infant growth and may increase LBW and PTB risks (26). Compared to Whites, African-American adults have significantly worse health measures that are related to chronic and frequent exposures to stress (27). In sum, segregation reduces the availability of resources and provision of services needed for enhancing maternal and fetal health and reducing LBW and PTB and increases maternal stress which is a risk factor for fetal growth. Therefore, segregation may be significantly contributing to racial disparities in maternal and child health including in LBW and PTB.

Even though segregation between African-Americans and Whites has decreased slightly between 1970 and 2000, it remains high (28). Segregation may explain the limited effects of individual-level socioeconomic status and education on racial health disparities in infant health (1, 3, 29). However, empirical studies of the effects of residential segregation on LBW and PTB have produced mixed results (30, 31), with some studies finding an adverse effect (3, 16, 32, 33), and at least one study finding a positive effect (34). Differences in modeling the relationship between segregation and health (35) may be leading to some of the mixed results in the literature. However, the mixed evidence highlights the need for further research in this area.

This study focuses on a very important aspect of the role of segregation in the health of African-American infants that has not been yet studied. We study how segregation effects on county-level LBW and PTB rates for African-American infants vary by the prevalence of these conditions. Specifically, we assess how segregation affects the entire distributions of these rates and not just their averages and evaluate if counties of high LBW and PTB prevalence are affected differently by segregation compared with counties of low

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

prevalence. In other words, we evaluate the segregation effects for counties at different prevalence levels, not just for the "average" county with average prevalence as done in previous research studies.

The motivation for this work is the substantial geographic variation in LBW and PTB rates for African-American infants (36). In 2000, the county LBW rates of African-American infants ranged from 4.1% to 20.8%, and the county preterm birth rates ranged from 4.8 to 24.2% (based on this study sample). Area differences in LBW and PTB prevalence reflect the underlying area differences in risk factors and resources that affect these conditions. These may include a wide range of factors that affect LBW and PTB such as maternal psychosocial health and economic, social, healthcare and environmental resources and that vary by segregation as mentioned above (37). Area differences in these variables may modify the effects of segregation on LBW and PTB rates, suggesting that segregation effects may vary with the prevalence of these conditions. The direction of the net result of these interactions is theoretically ambiguous. For example, segregation may have larger adverse effects in areas of more resources and lower LBW and PTB prevalence if segregation affects infant health primarily by limiting the access of minority groups to available resources. However, the effects of segregation may be attenuated in areas with more resources and fewer risk factors for LBW and PTB.

Identifying the potential heterogeneities in segregation effects by prevalence of LBW and PTB has major policy implications for improving the health of African-American infants and reducing infant health disparities. Evaluating this heterogeneity is essential for identifying the returns of residential policies and the areas that are most adversely affected by segregation and that may benefit most from reductions in segregation. To our knowledge, this is one of the first studies that evaluate the variation of segregation effects on LBW and PTB rates for African-American infants.

Methods

Data Source and Study Measures

The study sample includes counties of 100,000 or more residents with at least 50 African-American live births in 2000. We exclude counties with fewer than 50 African-American births in order to avoid biases in estimating the LBW and PTB rates due to low birth population in counties with low African-American representation. This county inclusion criterion results in an expected minimum of 5 African-American infants who are LBW or preterm per county. Three hundred sixty-eight counties fit these selection criteria and are included. The county-level data on LBW and PTB rates are obtained from the 2000 US Natality datasets. County-level data on race distributions are obtained from the 2000 US census data. The county is an appropriate geographic level for studying residential racial effects as there is significant between-county variation in both LBW and PTB rates and segregation. As a sensitivity check, we repeat the analysis using metropolitan statistical area (MSA) level measures and observe virtually comparable results.

The dependent variables are county-level rates of LBW and PTB among African-American infants. Specifically, the rates are defined as the proportions of all African-American infants born in the county at LBW and PTB. The county's segregation level is measured by the county-level dissimilarity and isolation indices that we construct for each county based on Massey and Denton's work (14). One important dimension of segregation is the evenness in residential distributions by race. In this study, this dimension relates to the evenness between the distributions of African-Americans and Whites over the census tracts within each county. The dissimilarity index measures departures from evenness. Specifically, dissimilarity identifies the extent to which the residential distributions of African-Americans

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

and Whites over the census tracts within a county deviate from a situation of complete desegregation (38). The isolation index is a measure of lack of residential exposure to individuals of another race within the county. Specifically, it measures the probability that African-Americans are exposed to other African-Americans instead of to Whites in the same county. Higher isolation may be due to the concentration of African-Americans in the same residential neighborhood(s) within the county. The continuous dissimilarity and isolation indices may vary between 0 (no segregation) and 1 (complete segregation). Table 1 provides the formulas for calculating these segregation indices.

Quantile Regression Approach

We evaluate the heterogeneity of residential segregation effects by LBW and PTB prevalence using quantile regression (QR) (39, 40). The QR model estimates the segregation effects on the quantiles of county-level LBW and PTB rates. Further, QR evaluates the heterogeneity in segregation effects on LBW and PTB rates by "unobserved" county-level factors that determine the county's rank on the LBW and PTB distributions (such as at high or low quantiles of these rates). This is because the net value of these unobserved factors are held constant at the specific LBW (or PTB) rate quantile for which the segregation effect is being estimated (41). In other words, the QR essentially evaluates the interactions between residential segregation and these unobserved factors that are relevant for LBW and PTB rates.

The QR model can be represented as follows: (41)

$$H = \mathrm{Q}(R, \mathbf{X}, U), \qquad (1)$$

where H represents the county-level LBW or PTB rate, R represents the county-level residential segregation measure, X is a vector of the model covariates, and $U \sim (0, 1)$ is a uniformly distributed ranking variable that may be thought of as representing the net level of the area (county) factors that are relevant for LBW and PTB and that may include maternal health risks and economic, social, healthcare, environmental and other resources that are relevant for H and that determine the county's rank on the H distribution, conditional on R and $\mathbf{X}$. U is the rank variable that results in counties with similar segregation levels to be at different locations of H's distribution. For quantile rank q, where q varies between 0 and 1, $\mathrm{Q}(R, \mathbf{X}, q)$ is the conditional qth quantile of H.

Since it is impossible to measure all the area-level risk factors and resources (maternal health risks and area resources) that are relevant for LBW and PTB (given that most of the etiology of these conditions remains unknown), QR provides a very flexible and informative model to identify the heterogeneity in residential segregation effects. Several studies report unmet needs for relevant resources in areas of high LBW and PTB prevalence, (42) which we also find as described below.

It is important to emphasize that QR is not estimated by stratifying the sample by the quantiles of LBW and PTB rates and estimating regressions for stratified samples, which leads to sample selection bias. At each quantile of LBW or PTB rate, QR is estimated using the whole sample. We estimate the QR model on LBW and PTB rate quantiles 0.05 through 0.95 in increments of 0.05 and estimate the standard errors using bootstrap with 2,000 replications. We test for differences in the segregation effects across the quantiles (43). As a reference, and in order to evaluate how the segregation effects at the average LBW and PTB rates compare to those at the quantiles, we also estimate the segregation effect on the means of these rates using ordinary least squares (OLS).

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Empirical Model

We estimate the effects of the two dissimilarity and isolation segregation measures independently and separately for LBW and PTB rates (which are the dependent variables) -- a total of four models are estimated. In our primary specification, we do not adjust for additional independent socioeconomic or demographic variables given that theoretically segregation may affect LBW and PTB rates by causally affecting these variables. However, it is also possible that segregation may correlate due to other reasons (such as non-random self-selection into residential neighborhoods) with some factors that are relevant for LBW/ PTB. In that case, including segregation as the only independent variable may result in biased estimates of the segregation effects. Therefore, we re-estimate the above four models adjusting for theoretically relevant factors for LBW and PTB that may also relate to segregation as reported in the literature (3, 16, 34, 44, 45) and that may proxy for potential unobserved confounders, focusing on variables that may reflect self-selection into neighborhoods. These include African-American rates of births to teen mothers, female college-level or higher education and prenatal care initiation in the first trimester, poverty rates and female labor force participation. These variables were obtained from the 2000 US census data and Natality datasets.

Results

Table 2 reports the distributions of the study variables. The sample LBW and PTB rates are 13% and 17% percent, respectively. On average the dissimilarity and isolation indices are 0.53 and 0.38 respectively.

Table 3 reports the residential segregation effects at quantiles 0.1, 0.25, 0.5, 0.75 and 0.9 of LBW and PTB rates, and at the means of these rates. The unadjusted and adjusted segregation effects are overall similar. Segregation has heterogeneous effects across the LBW and PTB rate distributions. At lower quantiles of LBW and PTB rates (i.e., at lower prevalence of LBW and PTB), segregation significantly increases these rates. Specifically, a 0.1-point increase in the dissimilarity index (which ranges from 0 to 1) is associated with an increase in LBW and PTB rates by about 1 percentage-point at the 0.1 quantile.[1] Similarly, a 0.1-point increase in the isolation index is associated with an increase in LBW and PTB rates by about 0.6-0.7 percentage-points at the 0.1 quantile.

In contrast, the segregation effects decrease and generally become insignificant at higher quantiles (i.e. at higher prevalence of LBW and PTB). The dissimilarity index has no significant effects on quantiles 0.75 and higher. The isolation index has no significant effects at the 0.9 and 0.95 quantiles of LBW and PTB rates in addition to an insignificant effect at the 0.75 quantile of LBW rate in the adjusted model. The differences in segregation effects across the five quantiles in Table 3 are significant in the unadjusted and adjusted models for both segregation measures and LBW and PTB rates. Figures 1 and 2 show the adjusted residential segregation effects on quantiles 0.05 through 0.95 of LBW and PTB rates. As can be seen, the pattern of heterogeneity in segregation effects is consistent across the entire LBW and PTB rate distributions. Similar trends are observed in the unadjusted models. The MSA-level results show a similar pattern to the county-level analyses (available from authors upon request).

[1]These effects are derived from the coefficients of the dissimilarity index in the 0.1 quantile regressions for LBW and preterm birth rates. For example, the unadjusted dissimilarity coefficient in the 0.1 quantile regression for the LBW rate is 0.1. This indicates that counties that are fully segregated (with a dissimilarity index equal to 1) have a higher LBW rate at the 0.1 quantile by 0.1 points (when LBW rate is measured as a proportion between 0 and 1) compared to unsegregated counties (with a dissimilarity index of 0). This implies that a 0.1 point increase in the dissimilarity index is associated with a 0.01 point increase in the LBW rate when measured as a proportion or with a 1 percentage-point in that rate when measured as a percentage (between 0 and 100).

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

In sum, in areas where the county-level prevalence of LBW and PTB are at the lowest levels (0.1 quantile), a one-standard deviation increase in segregation increases LBW and PTB rates by about 10 percentage-points.[2] However, at the highest prevalence levels (0.9 quantile), the rates of LBW and PTB rates do not change significantly by either measure of residential segregation.

The segregation effects on the average LBW and PTB rates mask the heterogeneous effects across the entire distributions of these rates. The dissimilarity index effects on LBW rate mean are about half or less of those at the 0.1 quantile but much larger than the insignificant effect at the 0.9 quantile. For instance, a 0.1-point increase in the dissimilarity index increases the mean of LBW rate by about 0.27-0.4 percentage-points (compared to the 1 percentage-point at the 0.1 quantile). Similarly, the isolation index effects at means of LBW and PTB rates substantially underestimate the effects at the low quantiles and overestimate those at high quantiles.

Discussion

The study finds significant variation in segregation effects on LBW and PTB rates of African-American infants by the prevalence of these conditions. Specifically, we find that segregation worsens the LBW and PTB rates in areas with low prevalence, but overall has no such effects in areas of high prevalence. In other words, segregation has significant adverse effects only for areas ranking at the left margin of the LBW and PTB rate distributions. This suggests that segregation may be a secondary factor for infant health and racial disparities in areas of higher prevalence of LBW and PTB, which on average have fewer (need-adjusted) resources and more risk factors for fetal growth. In contrast, segregation appears to be more relevant to areas of lower prevalence of LBW and PTB, which are expected to have more economic, social, and healthcare resources and fewer risk factors for fetal growth. Table 4 lists the distribution of selected socioeconomic and healthcare characteristics, obtained from the 2000 US census data and the area resource files (46), across areas stratified by LBW rate quartiles. The concentration of community hospitals and hospital beds (including obstetric beds) and supply of physicians and nurses per capita are greater for areas with lower prevalence of LBW compared to areas with greater LBW prevalence. Furthermore, female education and labor force participation are significantly higher in areas with lower prevalence of LBW than higher prevalence.

Identifying the specific pathways that modify the segregation effects as described above is beyond the scope of this paper, partly because the etiologies of LBW and PTB and consequently the relevant resources and risk factors remain largely unknown. However, a potential explanation of this result may be that segregation reduces the access of African-Americans to within-area resources for maternal and infant health such as quality health care facilities, fresh-food outlets, and favorable employment opportunities (16, 23, 24). On the contrary, the segregation effects on access to within-area (county-level) resources may become less relevant in areas that lack needed resources as is expected for areas with very high prevalence of LBW and PTB. We are unable to investigate directly in this paper whether the observed heterogeneity in segregation effects results from reduced access (due to segregation) to within-area resources in areas with more resources. Another potential related explanation is that segregation effects become less relevant in areas with high concentrations of risk factors for LBW and PTB, such as poor maternal health and environmental risks (22). Our findings highlight the importance of and need for future

[2]We calculate these by multiplying the standard deviations of the segregation indices shown in Table 2 (0.13 and 0.22 for the dissimilarity and isolated indices, respectively) by the regression coefficients reported in Table 3. For example, a one-standard deviation increase in the dissimilarity index increases the LBW rate at the 0.1 qunatile by 0.013 (0.13*0.1) or 1.3 percentage-points.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

research to uncover the pathways that contribute to the observed differences in segregation effects on LBW and PTB rates by prevalence.

The study findings have important implications for public policymaking to improve the health of African-American infants and reduce racial health disparities. The results suggest that policies that reduce segregation may on their own reduce LBW and PTB rates of African-American infants in areas of low prevalence, but not in areas of high prevalence. The findings suggest that other factors may be playing important roles in areas of high LBW and PTB prevalence among African-American infants, highlighting the need for future studies to identify them.

One limitation of the study is the unavailability of robust measures for relevant area-level characteristics and risk factors to evaluate directly the pathways through which segregation effects occur. As discussed above, this is partly because of the overall unknown etiology of LBW and PTB. However, this highlights an important direction for future studies of segregation and child health disparities. Another limitation that is also common to previous studies of this question is the possibility of confounding in segregation effects. However, observing similar segregation effects after adjusting for demographic and socioeconomic factors that are theoretically relevant for both self-selection into residential neighborhoods and LBW and PTB provides assurance against this bias. Other methods that account further for bias due to unobservable factors such as instrumental variables are infeasible with the available data sources for this study.

Acknowledgments

This work was supported in part by NIH 1R03DE018394 and CDC 1R01DD000295.

References

1. Elo TI, Jennifer FC, Iliana VK, et al. Neighbourhood deprivation and small-for-gestational-age term births in the United States. Paediatric and Perinatal Epidemiology. 2009; 23(1):87–96. [PubMed: 19228318]
2. Grady SC, Ramírez IJ. Mediating medical risk factors in the residential segregation and low birthweight relationship by race in New York City. Health & place. 2008; 14(4):661–77. [PubMed: 18036867]
3. Osypuk TL, Acevedo-Garcia D. Are racial disparities in preterm birth larger in hypersegregated areas? American journal of epidemiology. 2008; 167(11):1295–304. [PubMed: 18367470]
4. Behrman, RE.; Butler, AS. Preterm birth: causes, consequences, and prevention. National Academies Press; Washington, DC: 2006. Committee on Understanding Premature Birth and Assuring Healthy Outcomes.
5. Hamilton BE, Martin JA, Ventura SJ. Births: Preliminary Data for 2008. Natl Vital Stat Rep. 2010; 58(16):18.
6. Paneth NS. The problem of low birth weight. Future Child. 1995; 5(1):19–34. [PubMed: 7633862]
7. Currie J. Healthy, Wealthy, and Wise: Socioeconomic Status, Poor Health in Childhood, and Human Capital Development. Journal of Economic Literature. 2009; 47(1):87–122.
8. Victora CG, Adair L, Fall C, et al. Maternal and child undernutrition: consequences for adult health and human capital. Lancet. 2008; 371(9609):340–57. [PubMed: 18206223]
9. Collins JW Jr, David RJ. Racial Disparity in Low Birth Weight and Infant Mortality. Clinics in Perinatology. 2009; 36(1):63–73. [PubMed: 19161865]
10. Gee GC. A multilevel analysis of the relationship between institutional and individual racial discrimination and health status. Am J Public Health. 2008; 98(9 Suppl):S48–56. [PubMed: 18687618]

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

11. Collins CA. Racism and health: segregation and causes of death amenable to medical intervention in major U.S. cities. Annals of the New York Academy of Sciences. 1999; 896:396–8. [PubMed: 10681933]
12. David RJ, Collins JW Jr. Bad outcomes in black babies: race or racism? Ethnicity & disease. 1991; 1(3):236–44. [PubMed: 1842536]
13. Colen CG, Geronimus AT, Bound J, et al. Maternal upward socioeconomic mobility and black-white disparities in infant birthweight. Am J Public Health. 2006; 96(11):2032–9. doi:AJPH. 2005.076547 [pii] 10.2105/AJPH.2005.076547. [PubMed: 17018818]
14. Massey DS, Denton NA. The Dimensions of Residential Segregation. Social Forces. 1988; 67(2): 281–315.
15. Carr, JH.; Kutty, NK. Segregation: The Rising Costs for America. Routledge; New York: 2008.
16. Acevedo-Garcia D, Osypuk TL, McArdle N, et al. Toward a policy-relevant analysis of geographic and racial/ethnic disparities in child health. Health Aff (Millwood). 2008; 27(2):321–33. [PubMed: 18332486]
17. Williams DR. Race, socioeconomic status, and health. The added effects of racism and discrimination. Ann N Y Acad Sci. 1999; 896:173–88. [PubMed: 10681897]
18. Ahmed AT, Mohammed SA, Williams DR. Racial discrimination & health: pathways & evidence. Indian J Med Res. 2007; 126(4):318–27. [PubMed: 18032807]
19. Williams DR, Mohammed SA. Discrimination and racial disparities in health: evidence and needed research. J Behav Med. 2009; 32(1):20–47. doi:DOI 10.1007/s10865-008-9185-0. [PubMed: 19030981]
20. Darden JT. The Residential Segregation of Blacks in Detroit, 1960 1970. International Journal of Comparative Sociology. 1986; 17(1-2):8.
21. Krieger N. Embodying inequality: a review of concepts, measures, and methods for studying health consequences of discrimination. Int J Health Serv. 1999; 29(2):295–352. [PubMed: 10379455]
22. Currie J, Neidell M, Schmieder JF. Air Pollution and Infant Health: Lessons from New Jersey. Journal of Health Economics. 2009; 28(3):688–703. [PubMed: 19328569]
23. Lane SD, Keefe RH, Rubinstein R, et al. Structural violence, urban retail food markets, and low birth weight. Health & place. 2008; 14(3):415–23. [PubMed: 17928255]
24. Landrine H, Corral I. Separate and unequal: residential segregation and black health disparities. Ethnicity & disease. 2009; 19(2):179–84. [PubMed: 19537230]
25. Schulz AJ, Williams DR, Israel BA, et al. Racial and spatial relations as fundamental determinants of health in Detroit. Milbank Q. 2002; 80(4):677–707. iv. [PubMed: 12532644]
26. Morenoff JD. Neighborhood mechanisms and the spatial dynamics of birth weight. Ajs. 2003; 108(5):976–1017. [PubMed: 14560732]
27. Geronimus AT. Black/white differences in the relationship of maternal age to birthweight: A population-based test of the weathering hypothesis. Social Science & Medicine. 1996; 42(4):589–97. [PubMed: 8643983]
28. Iceland, J.; Weinberg, DH.; Steinmetz, E. Racial and Ethnic Residential Segregation in the United States: 1980-2000. Census 2000 Special Reports. 2002. CENSR-3
29. Pearl M, Braveman P, Abrams B. The relationship of neighborhood socioeconomic characteristics to birthweight among 5 ethnic groups in California. Am J Public Health. 2001; 91(11):1808–14. [PubMed: 11684609]
30. Walton E. Residential segregation and birth weight among racial and ethnic minorities in the United States. Journal of health and social behavior. 2009; 50(4):427–42. [PubMed: 20099449]
31. Bell JF, Zimmerman FJ, Almgren GR, et al. Birth outcomes among urban African-American women: a multilevel analysis of the role of racial residential segregation. Soc Sci Med. 2006; 63(12):3030–45. [PubMed: 16997438]
32. Laveist TA. Segregation, poverty, and empowerment: health consequences for African Americans. Milbank Q. 1993; 71(1):41–64. [PubMed: 8450822]
33. Grady SC. Racial disparities in low birthweight and the contribution of residential segregation: A multilevel analysis. Social Science & Medicine. 2006; 63(12):3013–29. [PubMed: 16996670]

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

34. Pickett KE, Collins JW Jr. Masi CM, et al. The effects of racial density and income incongruity on pregnancy outcomes. Soc Sci Med. 2005; 60(10):2229–38. [PubMed: 15748671]
35. Acevedo-Garcia D, Osypuk TL. Invited commentary: residential segregation and health--the complexity of modeling separate social contexts. American journal of epidemiology. 2008; 168(11):1255–8. [PubMed: 18974060]
36. Thompson LA, Goodman DC, Chang CH, et al. Regional variation in rates of low birth weight. Pediatrics. 2005; 116(5):1114–21. [PubMed: 16263997]
37. Acevedo-Garcia D, Lochner KA, Osypuk TL, et al. Future directions in residential segregation and health research: a multilevel approach. Am J Public Health. 2003; 93(2):215–21. [PubMed: 12554572]
38. James DR, Taeuber KE. Measures of Segregation. Sociological Methodology. 1985; 15:1–32.
39. Koenker R, Bassett G. Regression Quantiles. Econometrica. 1978; 46:33–50.
40. Koenker R, Hallock KF. Quantile Regression. Journal of Economic Perspectives. 2001; 15(4):143–56.
41. Chernozhukov V, Hansen C. An IV Model of Quantile Treatment Effects. Econometrica. 2005; 73(1):245–61.
42. Goodman DC, Fisher ES, Little GA, et al. Are neonatal intensive care resources located according to need? Regional variation in neonatologists, beds, and low birth weight newborns. Pediatrics. 2001; 108(2):426–31. [PubMed: 11483810]
43. Hao, L.; Naiman, D. Quantitative applications in the social sciences. Sage Publications; 2007.
44. Vinikoor LC, Kaufman JS, MacLehose RF, et al. Effects of racial density and income incongruity on pregnancy outcomes in less segregated communities. Social science & medicine (1982). 2008; 66(2):255–9.
45. Sparks PJ. Do biological, sociodemographic, and behavioral characteristics explain racial/ethnic disparities in preterm births? Social Science & Medicine. 2009; 68(9):1667–75. [PubMed: 19285373]
46. Area Resource File [database on the Internet]. Bureau of Health Professions; Rockville, MD: 2006.

NIH-PA Author Manuscript
NIH-PA Author Manuscript
NIH-PA Author Manuscript

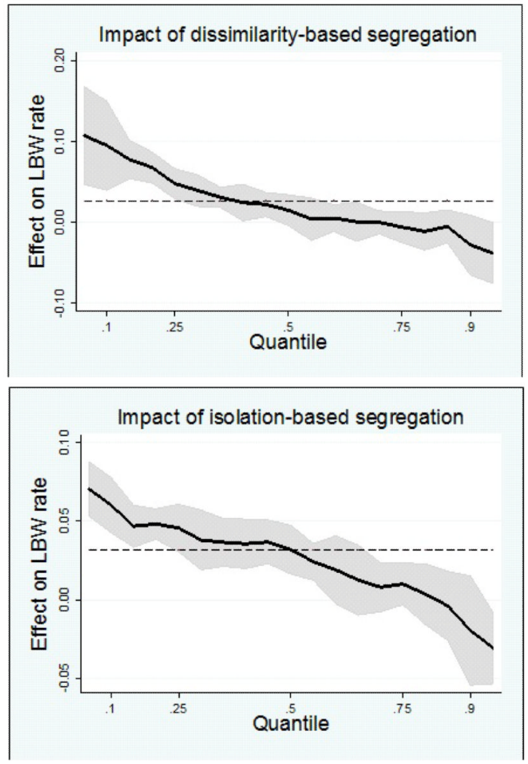

Figure 1.
reports the effects of the residential segregation status based on the dissimilarity and isolation indices on the quantiles and mean of the LBW rate of African-American infants (solid line) from the unadjusted model. Shaded areas represent the 95% confidence intervals of the quantile effects. The ordinary least square average effect is represented by the dashed line as a reference.

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

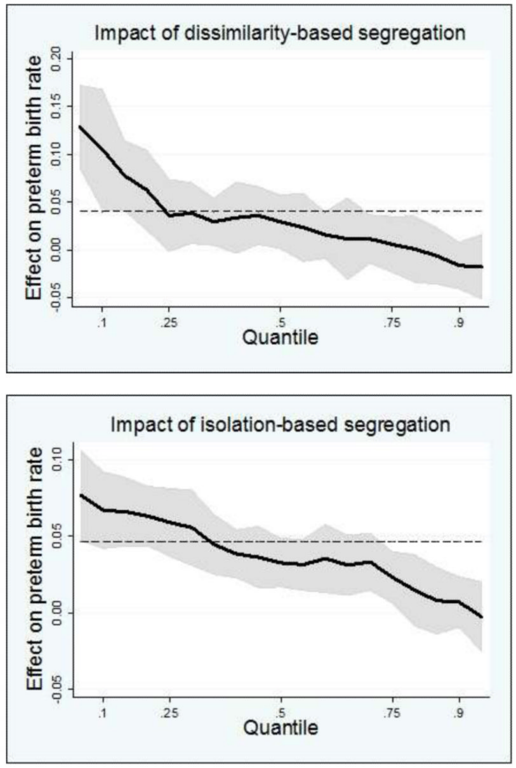

Figure 2.
reports the effects of the residential segregation status based on the dissimilarity and isolation indices on the quantiles and mean of the preterm birth rate of African-American infants (solid line) from the unadjusted model. Shaded areas represent the 95% confidence intervals of the quantile effects. The ordinary least square average effect is represented by the dashed line as a reference.

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 1

Measures of segregation

Dimension	Evenness	Exposure
Index	Dissimilarity index (D)	Isolation index (xP*x)
Formula	$D = \sum_{i=1}^{n}\left[\frac{t_i \mid p_i - P}{2TP(1-P)}\right]$	$xP^{*}x = \sum_{i=1}^{n}\left[\left(\frac{x_i}{X}\right)\left(\frac{x_i}{t_i}\right)\right]$
Description	The unevenness of the distribution of two groups in a residential area relative to an ideal even distribution. It is based on a scale ranging from 0 (no segregation) to 1 (complete segregation)	The extent of a lack of interaction between minority and majority group members
Interpretation	The proportion of minority members (African-Americans) who would have to change their area of residence for evenness to be achieved	The extent to which African-Americans are exposed to one another, and not to Whites

Notation:

t_i = total census tract ‘i’ population (African-Americans and Whites)

p_i = minority proportion in census tract i

T = population size in county

P = minority proportion in county

n = number of census tracts

X = number of members of minority group in county

x_i = number of X members in census tract

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 2

Description of Study Variables

Variable	Description	Mean (standard deviation)
Low birth weight (LBW) rate	The rate of African-American infants born at less than 2,500 grams	0.13 (0.02)
Preterm birth rate	The rate of African-American infants born before 37 completed weeks of gestation	0.17 (0.03)
Dissimilarity segregation	Indicator for uneven African-American-White distribution ranging from 0 (no segregation) to 1 (complete segregation)	0.53 (0.13)
Isolation segregation	Indicator for extent to which African-Americans are exposed to one another, and not to Whites	0.38 (0.22)
Teenage mothers	The proportion of African-American mothers who are 13 to 19 years old (in 2000)	0.20 (0.06)
Education	The proportion of African-American mothers who have a bachelor's degree or higher education (in 2000)	0.12 (0.08)
Prenatal care	The proportion of African-American mothers who initiated prenatal care in the 1st trimester of pregnancy (in 2000)	0.74 (0.08)
Poverty level	The proportion of African-Americans aged 18-64 below the poverty level (in 1999)	0.35 (1.91)
Female labor force participation	The proportion of African-American women in labor force (in 2000)	0.62 (0.06)

NIH-PA Author Manuscript

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 3

Quantile and Mean Effects of Residential Segregation on Low Birth Weight (LBW) and Preterm Birth Rates

		Quantile Effect (Quantile)					Mean Effect
		0.1	**0.25**	**0.5**	**0.75**	**0.9**	
LBW rate							
Dissimilarity	Unadjusted a	0.100*** (0.018)	0.053*** (0.010)	0.033*** (0.011)	0.007 (0.011)	−0.0009 (0.018)	0.041*** (0.010)
	Adjusted a	0.095*** (0.018)	0.048*** (0.010)	0.015 (0.011)	−0.006 (0.011)	−0.028 (0.022)	0.027*** (0.010)
Isolation	Unadjusted a	0.064*** (0.010)	0.048*** (0.007)	0.038*** (0.005)	0.016** (0.006)	−0.002 (0.008)	0.036*** (0.006)
	Adjusted a	0.060*** (0.009)	0.046*** (0.008)	0.032*** (0.008)	0.010 (0.009)	−0.020 (0.013)	0.031*** (0.006)
Preterm birth rate							
Dissimilarity	Unadjusted a	0.095*** (0.016)	0.042** (0.018)	0.045*** (0.012)	0.020 (0.015)	0.016 (0.018)	0.049*** (0.012)
	Adjusted a	0.105*** (0.028)	0.036* (0.019)	0.029** (0.014)	0.006 (0.019)	−0.017 (0.014)	0.040*** (0.013)
Isolation	Unadjusted b	0.064*** (0.013)	0.057*** (0.010)	0.048*** (0.007)	0.030*** (0.010)	0.013 (0.011)	0.048*** (0.007)
	Adjusted b	0.067*** (0.014)	0.059*** (0.011)	0.033*** (0.009)	0.023** (0.009)	0.007 (0.010)	0.046*** (0.007)

The table reports the effects of county-level segregation based on the dissimilarity and isolation indices on the quantiles and means of county LBW and preterm birth rates. Adjusted results are obtained from the model including demographic and socioeconomic variables. *, ** and *** indicate p values <0.1, < 0.05 and <0.01, respectively. Standard errors of segregation effects are in parentheses; a and b indicate that the segregation effects are significantly different between the five quantiles at p < 0.001 and < 0.01, respectively.

NIH-PA Author Manuscript NIH-PA Author Manuscript NIH-PA Author Manuscript

Table 4

Area-Level Characteristics by Low Birth Weight Rate Quartiles

Variables	Description	Low birth weight quartiles [rate ranges] ≤0.25 [0.041-0.113] (N=92)	>0.25 – 0.5 [0.114-0.126] (N=92)	>0.5 – 0.75 [0.127-0.140] (N=92)	>0.75 – 1.0 [0.141-0.208] (N=92)
Community hospital [a]	The number of short term community hospitals in county per 100 LBW infants (in 2000)	4.37 (4.35)	2.65 (2.27)	2.57 (1.64)	2.94 (2.71)
Hospital beds [a]	The number of hospital beds in county per 100 LBW infants (in 2000)	1133 (1164)	752.9 (531.8)	750.0 (437.7)	769.8 (521.3)
Not-for-profit hospital beds [a]	The number of not-for-profit hospital beds in county per 100 LBW infants (in 2000)	802.5 (916.9)	509.3 (421.3)	489.0 (369.0)	471.8 (472.7)
NICU beds	The number of neonatal intensive care beds in county per 100 LBW infants (in 2000)	13.90 (23.94)	11.13 (12.11)	15.12 (15.10)	10.87 (11.13)
Obstetric beds [a]	The number of neonatal obstetric beds in county per 100 mothers of LBW infants (in 2000)	59.74 (48.64)	40.06 (30.58)	42.02 (25.65)	41.56 (26.51)
Patient care physician [a]	The number of patient care physicians in county per 100 LBW infants (in 2000)	864.6 (1030)	519.0 (394.5)	479.0 (299.0)	435.2 (344.7)
Registered nurses – 1 [b]	The number of registered nurses in county per 10,000 population (in 2000)	83.99 (36.61)	77.25 (33.01)	75.44 (35.91)	72.78 (40.27)
Registered nurses – 2 [a]	The number of registered nurses in county per 100 LBW infants (in 2000)	3390 (2950)	1703 (1226)	1526 (1219)	1467 (1485)
Female labor force participation [a]	The proportion of African-American women in labor force (in 2000)	0.63 (0.06)	0.63 (0.06)	0.62 (0.05)	0.61 (0.05)
Education [a]	The proportion of African-American mothers who have a bachelor’s degree or higher education (in 2000)	0.15 (0.10)	0.12 (0.07)	0.11 (0.08)	0.09 (0.06)

Standard errors of means are in parentheses. N indicates the number of counties in the LBW quartile range. [a] and [b] indicate a significant difference in the means of these characteristics across the LBW rate quartiles (based on regression analysis) at p < 0.001 and < 0.01, respectively.